above normal, the chances being nearly 8 out of 10. The indicated average of the next three months is about 70.7°, which is 0.7° above normal.

Will this apply elsewhere?—The percentage of frequency that warm Junes are followed by dry Julys has been worked out for near-by States. These percentages appear on the small map, Figure 4. From Iowa to Indiana the chances of verification are better than 7 out of 10, but outside of this the percentage diminishes in regular zones. The verification is somewhat greater by State areas than by individual stations.

Practical applications.—When the end of a cool June has been reached without business activity in warm weather goods, such as palm beach suits, straw hats, bathing suits, electric fans, ice cream, soft drinks, etc,. the merchant wonders if June is a sample of the rest of the season. He could be advised that the chances were better than 7 out of 10 that July and also the next three months would average below normal in temperature. He could than take steps to unload stocks or contract rather than expand his business. His policies and the character of his advertising would be entirely different. Or if June is warm, warm weather enterprises, such as bathing beaches, amusement parks, and water-front real estate, could put on full speed ahead with the assurance that they had nearly 8 chances out of 10 of having a good run of business in the next three months.

Sarle has shown that the merchantability of Iowa corn is more largely determined by June temperature than by any other factor. If June is warm, it is almost safe to assert that very little of the corn will be frosted or immature. There is almost no correlation between merchantability and date of first killing frost in autumn, strange as this may seem, for the real damage is done, or advantage gained, in June.

The relationship between June temperature and corn yield is complicated by so many factors that it can not be expressed by simple correlation. However, the factors can be separated and measured, as this writer hopes to show in a future paper. It is sufficient to say at this time that a warm June produces luxuriant corn plants that are rated at a high percentage condition by crop reporters on July 1. What happens to the corn later on is not a fault in the structure of the plants, but is almost wholly due to the fact that more than 8 times out of 10 a warm June is followed by a dry July, and if dry it is most likely hot, as was shown in the first part of this paper. This cuts the yield but improves the merchantability as a rule.

Other correlations.—No other such large, simple correlations have been found, though nearly 300 have been worked out by computing-machine [5] methods. In a general way a regression formula coming from a correlation smaller than ± 0.30 will not give a prediction much better than guess work, yet by the method of partial correlation the indications of several previous months make it possible to say with an accuracy much better than guess work whether or not the month just ahead will be drier, wetter, warmer, or cooler than normal.

[5] "Correlation and Machine Calculation," Wallace and Snedecor, Iowa State College of Agriculture and Mechanic Arts, Official Publication, Vol. 23; No. 35; January 28, 1925.

A NEW METHOD OF CHARTING STORM FREQUENCY

By KEITH KELSEY

[Grand Central Terminal, New York City]

The usual method employed by meteorologists to indicate graphically the storminess of a given area is to plot on a map the number of cyclone centers crossing each 5° square in that area and then to draw lines through points of equal storminess. This method has several disadvantages:

The area of a 5° square in the vicinity of Tampa is, roughly, 30 per cent, or 24,000 square miles greater than the area of one near Duluth.

A chart of isoclones [6] on this basis is thus distorted in favor of the southerly latitudes in the Northern Hemisphere.

"The number of barometric minima per month passing through the 5° square surrounding Duluth" does not convey as clear a conception of conditions as does the more rational and apposite expression, "the number of barometric minima per month passing within 200 miles of Duluth."

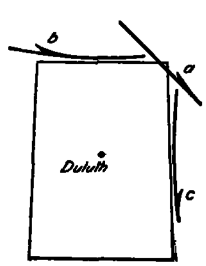

FIG. 1

A cyclone cutting the corner of the 5° square surrounding Duluth is counted for that city, while one moving due eastward 30 miles closer (*b*, fig. 1) or one passing due southward 85 miles closer (*c*, fig. 1) would not be so counted.

The 5° square is too large a unit to allow the chart to show to any considerable degree the effect of land and water areas upon cyclone paths.

A unit of area that does not involve these objections is a circle 400 miles in diameter. The shape of this unit gives equal weight to each storm regardless of its direction of travel or its latitude, while the size of the unit is such that sufficient data for good interpolation for an area the size of the United States are obtained.

The accompanying isoclonic chart was prepared using a circle of 400 miles diameter as the unit. The isoclones give the average number of cyclones passing within 200 miles of a given locality during the month of January. The necessary data were obtained from the track charts of the MONTHLY WEATHER REVIEW for the 40 Januarys, 1892 to 1921.

Tangent circles of 200 mile radius were carefully drawn on sheets of onion-skin paper the size of the track charts. Latitude and longitude register marks were drawn on these sheets so that when each was oriented on a track chart the centers of the tangent circles would be in the same geographical localities in every case. Cyclone track charts from 1885 to 1890 were on such a projection as to necessitate the use of ellipses to represent the circles of charts of other years.

One such prepared sheet of onion-skin paper was then clipped onto a cyclone chart with precise adjustment of the register marks. Next taking each storm track in order by number, all the cyclones were followed across the chart, a dot being placed within each circle crossed by the storm path. This same onion-skin sheet was used for 10 Januarys and when all the storm tracks of those 10 months were checked off the dots in each circle were totaled.

Upon the completion of four of these circled charts the figures in corresponding circles were added and the totals divided by 40 giving the average number of paths

[6] Contraction of isocyclone.

crossing each circle during the month of January or in other words the number of cyclones passing within 200 miles of the centers of the circles.

These average figures were then plotted upon a blank map at the centers of their corresponding circles. By interpolation, isoclones were drawn permitting values to be read for localities other than those at the centers of the construction circles.

Both individually and in comparison with others this isoclonic chart shows several interesting facts.

The influence of land and water on the place-frequency of storms is apparent from the shapes of the isoclones.

In the Pacific Coast Region the normal southeasterly trend of the isoclones is distorted by the prevalence of stagnant HIGHS in the dry, cold Plateau Region. That the majority of the North Pacific LOWS are forced to enter the continent at high latitudes and to move due east until the Rocky Mountains are crossed before turning southeastward, is plainly indicated by the chart.

In the lee of the Rockies the origin of the Colorado LOWS is evidenced by a well defined isoclonic maximum. The source of Texas LOWS is likewise clearly indicated.

The marked southerly trend of the isoclones in the Mississippi Valley is probably due to a number of causes, such as increased moisture supply, flat topography, and the closing together of the paths of South Pacific, Colorado, and Texas LOWS. The high maximum over the Great Lakes is due again chiefly to moisture supply, flat topography, the confluence of many storm paths, and, in addition, to the southward pressing effect of the Hudson Bay HIGH.

The presence of the Appalachian System is shown by the isoclonic minimum in that region. Further eastward the Atlantic Ocean causes a southerly dip in the isoclones before they are pushed to the north by the Bermuda HIGH.

A minor juncture of storm paths is marked by an isoclonic maximum off Newfoundland.

The steep gradient between Hudson Bay and the Great Lakes is probably more apparent than real. The use of Canadian Weather Service maps would no doubt have modified the chart in that locality.

In conclusion it may be pointed out that this type of chart, as well as being of general climatic interest, is of particular value, due to its construction, in investigations of the effects of cyclonic frequency upon health and human efficiency.

CORRELATION IN SEASONAL VARIATIONS OF WEATHER—A FURTHER STUDY OF WORLD WEATHER[7]

By GILBERT T. WALKER

[Abstracted by A. J. Henry]

This paper is a continuation of the series, Correlation in Seasonal Variations of Weather, begun in Part IV of volume 24 of the Indian Meteorological Memoirs. In that paper Doctor Walker presented the results of a preliminary study of the relationships between 17 centers of action of which 15 were centers for pressure and 2 for rainfall.

Since the publication of the memoir just mentioned the survey of the relationships has been carried a step farther, and the author now presents data of relationships for the entire year, whereas in the earlier publication the data were applicable only to summer and winter.

The number of years of data for the several centers of action is roughly 43 for the great majority of centers and but about 20 for Samoa and Alaska. In discussing the significance of correlation coefficients derived from records varying in length as indicated it is pointed out that the probable value of a correlation coefficient based on random data would be 0.151 and 0.103 for the long and short series, respectively.

In the Alaska or Samoa tables there will be found in the column for contemporary quarters 17 coefficients with other centers based on data of about 20 years; so that the probable value of the greatest of 17 random coefficients is 0.151×3.04 or 0.459.[8]

Two tables are presented in which the probability of a number of random coefficients exceeding certain limiting values (0.459 in the longer series and 0.305 in the shorter) is given. From these tables it is concluded that the probability of a random coefficient diminishes rapidly with growth in its size. It follows therefore for the short-period records of Alaska and Samoa that though it is as likely as not that one of the random coefficients will exceed 0.46 there is a chance of only about 1 in 3 of the greatest exceeding 0.5, 1 in 5 exceeding 0.55, 1 in 9 of exceeding 0.6, and 1 in 34 of exceeding 0.7. For the long record stations this feature is still more pronounced, the chance of one coefficient exceeding 0.6 is only 1 in 380 times.

The so-called centers of action of greatest interest to North American meteorologists are, perhaps, those of Alaska, Honolulu, and Charleston. For this reason the full tables of correlation coefficients between these centers and other distant centers as worked out by Doctor Walker are presented below. Doctor Walker's comment upon each table is also reproduced.

[7] Calcutta, Indian Meteorological Memoirs, 24, Part IX, pp. 275-332.

[8] For the development of this expression the reader is referred to Vol. XXI, Part IX, p. 15, Ind. Met. Mem.